CHAPTER 12

Protein-Energy Malnutrition and Weight Loss

KEY TEACHING POINTS

- Classic findings of malnutrition (marasmus and kwashiorkor) are uncommon in malnourished patients from the industrialized world. Instead, hospitalized patients with malnutrition present with *decreased muscle mass* (evident from limb circumference measurements) and *decreased grip strength*.
- Decreased muscle mass and grip strength both accurately predict increased morbidity and mortality after major surgery.
- In patients with involuntary weight loss, 65% have a responsible *organic* disorder, which is usually evident during the initial history, physical examination, and laboratory testing.
- Significant underestimation of weight loss by the patient increases the probability of organic disease; significant overestimation increases the probability of nonorganic disease.

PROTEIN-ENERGY MALNUTRITION

I. INTRODUCTION

The most common cause of malnutrition worldwide is inadequate food supply, although in industrialized countries, malnutrition usually reflects increased nutrient loss (e.g., malabsorption, diarrhea, nephrotic syndrome), increased nutrient requirements (e.g., fever, cancer, infection, or surgery), or both. Among patients admitted to surgical services in industrialized nations, 9% to 27% exhibit signs of severe malnutrition.[1,2]

II. THE FINDINGS

In children of developing nations, there are two distinct syndromes of protein-energy malnutrition: **marasmus** (profound weight loss, muscle wasting, and fat wasting) and **kwashiorkor** (abdominal distension, edema, and hypopigmented hair). In industrialized countries, however, most malnourished patients have less dramatic symptoms and present instead with combinations of low body weight, atrophy of muscle and subcutaneous fat, weakness, and various laboratory abnormalities (e.g., low albumin or other serum proteins).

A. ARM MUSCLE CIRCUMFERENCE

Arm muscle circumference (AMC) is a decades-old anthropometric measurement of the amount of muscle in the arm, which theoretically reflects the total amount

of muscle or protein in the body. The clinician measures the upper arm circumference (C_a, using a flexible tape measure) and the triceps skinfold thickness (h, using calipers) and estimates AMC with the following formula:*

$$\text{AMC} = C_a - \pi h$$

Age- and sex-standardized values of the normal AMC have been published.[3] The technique for forearm muscle circumference is similar.

B. GRIP STRENGTH

Based on the hypothesis that malnutrition influences the outcome of surgical patients and that muscle weakness is an important sign of malnutrition, Klidjian et al. in 1980 investigated 102 surgical patients and demonstrated that hand grip strength accurately predicts postoperative complications.[4] In their method, the patient squeezes a simple handheld spring dynamometer 3 times, resting 10 seconds between each attempt, and the clinician records the highest value obtained. (Patients with arthritis, stroke, or other obvious causes of weakness are excluded.)

Age- and sex-standardized values of normal grip strength have been published.[5] Clinical studies of grip strength usually test the nondominant arm, but this may be unnecessary because studies show both arms are similar.[5]

Historically, clinicians measured grip strength by rolling up an adult aneroid blood pressure cuff (making a cylinder of about 2 inches in diameter with rubber bands on each end), inflating the cuff to 20 mm Hg, and then asking the patient to squeeze the cuff. The subsequent sphygmomanometer reading (in mm Hg) is a measure of grip strength; formulas for converting these readings to dynamometer readings (in kilograms or pounds) have been published.[6]

III. CLINICAL SIGNIFICANCE

EBM Box 12.1 addresses the accuracy of physical examination in predicting significant postoperative complications among patients undergoing major surgery. In these studies, complications are significant if they prolong hospital stay, threaten the patient's life, or cause death (e.g., sepsis, wound infections, myocardial infarction, or stroke).

In these studies, the findings of reduced arm or forearm muscle circumference (likelihood ratio [LRs] = 2.5 to 3.2), reduced grip strength (LR = 2.5), and low body weight (LR = 2) all modestly increase the probability of postoperative complications. Normal grip strength *decreases* the probability of complications (LR = 0.4). Interestingly, the presence of recent weight loss has little diagnostic value in predicting complications, possibly because this finding not only identifies patients with weight loss from malnutrition (which should increase complications) but also overweight patients who voluntarily lose weight before surgery (which should decrease complications).

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*This formula assumes that the arm is a cylinder of only skin and muscle (i.e., disregards the humerus). To derive this formula, (1) AMC = πd_1 (d_1 = diameter of muscle component of the arm); (2) $d_1 = d_2 - h$ (d_2 = diameter of arm; h = skinfold thickness, which since the skin is pinched, actually includes a *double* layer of skin and subcutaneous tissue); and therefore (3) AMC = $\pi d_1 = \pi(d_2 - h) = \pi d_2 - \pi h = C_a - \pi h$. If the clinician desires to directly enter the skinfold thickness in mm (as it is measured), 0.314 is substituted for π in the formula (i.e., AMC and C_a are measured in centimeters).

EBM BOX 12.1
*Protein-Energy Malnutrition and Major Surgical Complications**

Finding (Reference)†	*Sensitivity (%)*	*Specificity (%)*	Likelihood Ratio‡ if Finding Is	
			Present	*Absent*
Body Weight				
Weight loss >10%[4,7-10]	15-75	47-88	1.4	NS
Low body weight[4,8,9,11]	11-35	83-97	2.0	NS
Anthropometry				
Upper AMC <85% predicted[4,8,9]	26-38	83-91	2.5	0.8
Forearm muscle circumference <85% predicted[4,8,9]	14-42	85-97	**3.2**	0.8
Muscle Strength				
Reduced grip strength[4,5,8,9,12-15]	33-90	46-93	2.5	0.4

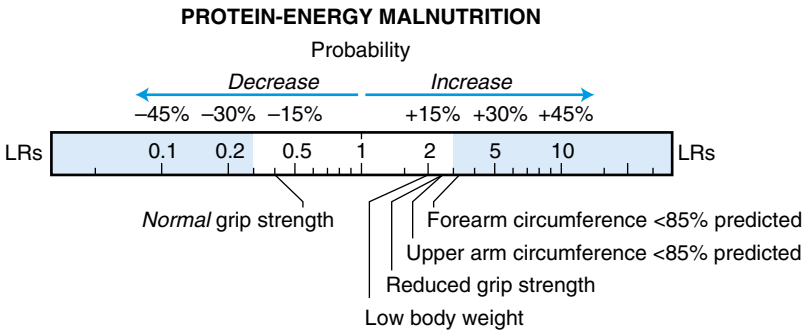
*Diagnostic standard: In each of these studies, *disease* is defined as a major postoperative complication, including instances prolonging hospital stay, threatening the patient's life, or causing death.

†Definition of findings (all findings from preoperative physical examination): For *weight loss greater than 10%*, (Recalled usual weight – Measured weight)/(Recalled usual weight) > 10%; for *low body weight*, weight-for-height is less than the normal lower limit,[11] less than 90% of predicted,[4] or less than 85% of predicted;[8,9,14,15] for *predicted AMC*, standardized values published in reference 3;[3] for *forearm muscle circumference less than 85%*, <20 cm in men and <16.3 cm in women;[4,9] and for *reduced grip strength*, specific thresholds differ but all correspond closely to published age- and sex-standardized abnormal values based upon reference 5.

‡Likelihood ratio (LR) if finding present = positive LR; LR if finding absent = negative LR.

AMC, Arm muscle circumference; *NS,* not significant.

Click here to access calculator



WEIGHT LOSS

I. INTRODUCTION

Involuntary weight loss reflects diuresis, decreased caloric intake, or the increased caloric requirements of malabsorption, glucosuria, or a hypermetabolic state. Organic disease is diagnosed in 65% of patients presenting with involuntary weight loss exceeding 5% of their usual weight (most commonly cancer and gastrointestinal disorders, although virtually any chronic disease may cause weight loss), and psychiatric disorders are diagnosed in 10% of patients (depression, anorexia nervosa, schizophrenia). In 25% of patients, the cause remains unknown despite at least 1 year of follow-ups.[16-20]

II. CLINICAL SIGNIFICANCE

Weight loss is rarely due to occult disease, and most diagnoses are made during the initial evaluation, including the patient interview, physical examination, and basic laboratory testing.[16,17,19,20]

In patients with involuntary weight loss, the presence of alcoholism (LR = 4.5) and cigarette smoking (LR = 2.2) increase the probability that an organic cause will be discovered during a 6-month follow-up, whereas prior psychiatric disease (LR = 0.2) and a *normal* initial physical examination (LR = 0.4) decrease the probability of discovering organic disease.[21] Also, the patient's perceptions of the weight loss—whether he or she significantly underestimates or overestimates it—help predict the final diagnosis. The patient is asked to estimate his or her weight before the illness (W) and the amount of weight lost (E). The observed weight loss (O) is the former weight (W) minus the current measured weight. Significant *underestimation* of weight loss, defined as ($O - E$) greater than 0.5 kg, predicts an *organic* cause of weight loss with a sensitivity of 40%, specificity of 92%, positive LR of 5.4, and negative LR of 0.6.[22] Significant *overestimation* of weight loss, defined as ($E - O$) greater than 0.5 kg, predicts a *nonorganic* cause of weight loss with a sensitivity of 70%, specificity of 81%, positive LR of 3.6, and negative LR of 0.4.[22]

The references for this chapter can be found on www.expertconsult.com.

REFERENCES

1. Baker JP, Detsky AS, Wesson DE, et al. Nutritional assessment: a comparison of clinical judgment and objective measurements. *N Engl J Med*. 1982;306(16):969–972.
2. Detsky AS, McLaughlin JR, Baker JP, et al. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987;11(1):8–13.
3. Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. *Am J Clin Nutr*. 1981;34:2540–2545.
4. Klidjian AM, Foster KJ, Kammerling RM, Cooper A, Karran SJ. Relation of anthropometric and dynamometric variables to serious postoperative complications. *Br Med J*. 1980;281:899–901.
5. Webb AR, Newman LA, Taylor M, Keogh JB. Hand grip dynamometry as a predictor of postoperative complications reappraisal using age standardized grip strengths. *JPEN J Parenter Enteral Nutr*. 1989;13(1):30–33.
6. Hamilton GF, McDonald C, Chenier TC. Measurement of grip strength: validity and reliability of the sphygmomanometer and Jamar grip dynamometer. *J Orthoped Sports Phys Ther*. 1992;16:215–219.
7. Windsor JA, Hill GL. Weight loss with physiologic impairment: a basic indicator of surgical risk. *Ann Surg*. 1988;207(3):290–296.
8. Klidjian AM, Archer TJ, Foster KJ, Karran SJ. Detection of dangerous malnutrition. *JPEN J Parenter Enteral Nutr*. 1982;6(2):119–122.
9. Hunt DR, Rowlands BJ, Johnston D. Hand grip strength—a simple prognostic indicator in surgical patients. *JPEN J Parenter Enteral Nutr*. 1985;9(6):701–704.
10. Katelaris PH, Bennett GB, Smith RC. Prediction of postoperative complications by clinical and nutritional assessment. *Aust N Z J Surg*. 1986;56:743–747.
11. Hickman DM, Miller RA, Rombeau JL, Twomey PL, Frey CF. Serum albumin and body weight as predictors of postoperative course in colorectal cancer. *JPEN J Parenter Enteral Nutr*. 1980;4(3):314–316.
12. Davies CWT, Jones DM, Shearer JR. Hand grip—a simple test for morbidity after fracture of the neck of the femur. *J Roy Soc Med*. 1984;77:833–836.
13. Mahalakshmi VN, Ananthakrishnan N, Kate V, Sahai A, Trakroo M. Handgrip strength and endurance as a predictor of postoperative morbidity in surgical patients: can it serve as a simple bedside test? *Int Surg*. 2004;89:115–121.
14. Kalfarentzos F, Spiliotis J, Velimezis G, Dougenis D, Androulakis J. Comparison of forearm muscle dynamometry with nutritional prognostic index, as a preoperative indicator in cancer patients. *JPEN J Parenter Enteral Nutr*. 1989;13:34–36.
15. Guo CB, Zhang W, Ma DQ, Zhang KH, Huang JQ. Hand grip strength: an indicator of nutritional state and the mix of postoperative complications in patients with oral and maxillofacial cancers. *Br J Oral Maxillofac Surg*. 1996;34:325–327.
16. Rabinovitz M, Pitlik SD, Leifer M, Garty M, Rosenfeld JB. Unintentional weight loss: a retrospective analysis of 154 cases. *Arch Intern Med*. 1986;146:186–187.
17. Marton KI, Sox HC, Krupp JR. Involuntary weight loss: diagnostic and prognostic significance. *Ann Intern Med*. 1981;95:568–574.
18. Lankisch PG, Gerzmann M, Gerzmann JF, Lehnick D. Unintentional weight loss: diagnosis and prognosis. The first prospective follow-up study from a secondary referral centre. *J Intern Med*. 2001;249:41–46.
19. Thompson MP, Morris LK. Unexplained weight loss in the ambulatory elderly. *J Am Geriatr Soc*. 1991;39:497–500.
20. Metalidis C, Knockaert DC, Bobbaers H, Vanderschueren S. Involuntary weight loss. Does a negative baseline evaluation provide adequate reassurance? *Eur J Intern Med*. 2008;19:345–349.
21. Bilbao-Garay J, Barba R, Losa-Garcia JE, et al. Assessing clinical probability of organic disease in patients with involuntary weight loss: a simple score. *Eur J Intern Med*. 2002;13:240–245.
22. Ramboer C, Verhamme M, Vermeire L. Patients' perception of involuntary weight loss: implications of underestimation and overestimation. *Br Med J*. 1985;291:1091.